

**REMARKS**

Review and reconsideration of the Office Action of March 23, 2005 is respectfully requested in view of the following remarks.

Claim 35 is amended to address a "lack of antecedent basis" rejection.

**Present Invention**

The invention concerns casting molds for casting metal, in particular the precision casting of fine parts and processes for production of casting molds. Rapid prototyping methods are known for the layer build up of such molds. However, the surface shows steps and graininess, the dimensional trueness is poor due to stress on the metal part during casting, the mold may shrink during sintering, and the mold usually requires sintering to gain sufficient strength for use in metal casting.

In accordance with the present invention, all the above problems are overcome by use of a ceramic comprised of

- coated ceramic coarse particles, and
- sinterable ceramic fine particles wherein the sintering temperature of the fine particles is at least 50°C below that of the coarse particles.

**Office Action**

Turning now to the Office Action, the paragraphing of the Examiner is adopted.

**Paragraphs 1 and 2 (Claim Rejections - 35 USC § 112)**

Claim 35 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. In Claim 35, "the support or reinforcing or casing mold" lacks antecedent basis.

Claim 35 has been amended.

**Paragraphs 3 - 8 (Claim Rejections - 35 USC § 103(a))**

Claims 21-22, 25-27, 30-33, and 39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Langer et al. in view of Naito et al.

Applicants respectfully traverse.

The present invention addresses the problem of the poor quality of metal parts made using molds made by a rapid prototyping process. The invention provides molds which have good dimensional stability in the green form (thus need not be fired), provide good surface quality (less steps and graininess) and, most importantly, produce metal castings not subject to warping and deformation as found in the state of the art.

Langer et al teaches the state of the art over which the present invention improves, and is not concerned with the deficiencies addressed by the present invention nor suggest the solutions provided by the present invention.

Naito et al concerns refractory lining materials, not mold materials. These materials are disclosed as having low thermal coefficient of expansion (TCE) (desirable for lining a furnace),

thus have no relevancy to the present invention wherein the thermal coefficient of expansion of the mold is high and thus substantially compatible with metals having high thermal coefficient of expansion.

No combination of these references can come close to the present invention. In fact, modifying Naito et al in the direction of the present invention (high TCE) would destroy Naito et al.

In the present invention all the above discussed problems endemic to state of the art rapid prototyping molds for metal foundry are overcome by use of a ceramic comprised of

- coated ceramic coarse particles and
- sinterable ceramic fine particles wherein the sintering temperature of the fine particles is at least 50°C below that of the coarse particles.

This combination provides

- high surface quality
- improved dimensional trueness of cast metal part due to better matching of mold TCT to metal TCE,
- substantially no sintering shrinkage, and
- sufficient strength to be used for foundry casting in the green state.

The references are now discussed in greater detail:

Langer et al.

Langer et al. teach 3-D printing for forming a casting mold. As such, Langer et al. merely represents the starting point of the present invention - the state of the art over which

the present invention is an improvement. Langer is no more relevant than US Patent 5,204,055 discussed in paragraph [0005] of the specification. As discussed in the present specification, it is known to produce such molds by a generative rapid prototyping process. However, such molds are characterized by

- the appearance of steps, graininess,
- an insufficient strength in the green form,
- shrinkage of the mold during sintering, and
- a mismatch between the high thermal coefficient of expansion (TCE) of metal and the low TCE of the ceramic mold, leading to tensions and warping of the foundry casting.

**Naito et al.**

Turning to Naito et al, this reference concerns unfired refractory bricks (bricks which need not be pre-fired prior to use, but are sufficiently stable prior to firing, and become fired during use in a furnace).

The problem with prior art unfired refractory bricks is that when fired, the area nearest the flame may become sintered, the area of the brick furthest from the flame may not be sintered but maintains strength due to remaining binders, but in an intermediate zone the brick is not fired but loses binder, thus is weak and liable to crack.

Naito et al solve the problem by use of a special three-binder mixture, whereby the weak zone of partially fired bricks is overcome.

This has nothing to do with the present invention.

Naito et al concern refractory bricks for use in lining furnaces or as substrates for parts being fired. The bricks of Naito et al should have a LOW TCE - the refractory bricks should line a furnace and maintain dimensional trueness - neither shrinking nor expanding during thermal cycling.

As disclosed at Naito et al. col. 31, lines 62 on:

On the other hand, when the siliceous binder, organic binder and phosphate type hardening agent are incorporated in amounts satisfying the requirement of the present invention, ... the thermal linear expansion or contraction was very small.

In great contrast, a critical feature of the present invention is the selection of a mold material having a good match between the high thermal coefficient of expansion (TCE) of metal and the material of the ceramic mold, leading to reduction in tensions and warping of the foundry casting. This feature is expressed in the present claim limitation that the thermal coefficient of expansion of the ceramic is above approximately  $7.5 \times 10^{-6} K^{-1}$

Further, Naito et al does not concern metal casting molds made by 3D printing.

Finally, on close reading of Naito et al, applicants note that this reference teaches

1-20 parts by weight siliceous binder (silicic acid)

2-15 parts by weight organic binder

0.5 to 20 parts by weight phosphate type hardening agent

100 parts by weight refractory aggregate.

The above siliceous binder is discussed in terms of "pot life" implying a solution (col. 5 line 42), is referred to as a solution (col. 5 line 41), and measured as 5-50% solids concentration in water. Thus, siliceous binder is in the form of a solution, not in the form of particles. The composition of Naito et al, in addition to being low TCE, is not relevant to the present composition.

Withdrawal of the rejection is respectfully requested.

Next, claims 23-24, 34-35, and 40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Langer et al. in view of Naito et al. and further in view of either Zoia et al. or Smith et al.

Applicants respectfully submit that, since the main references do not suggest the subject matter of the main claims, the secondary references can not provide suggestion for dependent claims properly depending from allowable main claims.

Withdrawal of the rejection is respectfully requested.

Next, claims 28-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Langer et al. in view of Naito et al. and further in view of Kington.

Applicants respectfully submit that, since the main references do not suggest the subject matter of the main claims, the secondary references can not provide suggestion for dependent claims properly depending from allowable main claims.

Withdrawal of the rejection is respectfully requested.

U.S. Application No.: 10/826,582  
AMENDMENT A

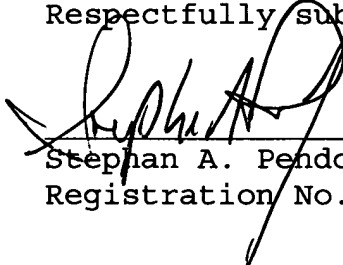
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Finally, claims 36-38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Frank et al. in view of Naito et al.

Applicants respectfully submit that, since the main references do not suggest the subject matter of the main claims, the secondary references can not provide suggestion for dependent claims properly depending from allowable main claims.

Withdrawal of the rejection is respectfully requested.

Respectfully submitted,



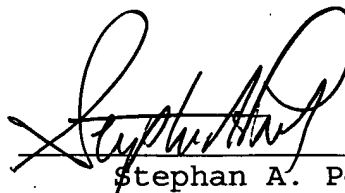
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Date: **June 23, 2005**

**CERTIFICATE OF MAILING AND AUTHORIZATION TO CHARGE**

I hereby certify that the foregoing AMENDMENT A for U.S. Application No. 10/826,582 filed April 16, 2004, was deposited in first class U.S. mail, postage prepaid, addressed: Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on **June 23, 2005**.

The Commissioner is hereby authorized to charge any additional fees which may be required at any time during the prosecution of this application without specific authorization, or credit any overpayment, to Deposit Account No. 16-0877.



Stephan A. Pendorf